

ADSORPTION STUDIES ON LEAD (II) IONS BY LOW; HIGH ESTERIFIED PECTIN AND PECTIN EXTRACTED FROM WATER HYACINTH LEAVES

Abd El- Rahman, S.A.; N. A. A. Hashem and A. A. Bakr

Regional Center for Food and Feed, Agric. Res. Center, Ministry of Agric., Giza, Egypt.

ABSTRACT

The adsorption of Pb(II) ions from aqueous solution by different pectin compounds was studied in a batch sorption system. In this study lead binding activity of high; low esterified pectin and pectin extracted from water hyacinth leaves as well as of kyanite was estimated under in vitro and in vivo conditions. The lead- binding capacity of all different pectin compounds was the highest within the pH range 4.0 – 8.0. The Langmuir and Freundlich sorption models were applied to describe the isotherms and sorption constants. Interactions among pectins could be well interpreted by the Langmuir model. Obtained results indicated that pectin compounds are favorable sorbents. The largest amount of Pb(II) ions were bound by pectin with the low degree of esterification. In experiments estimating lead removal from liver and kidney in rats preliminary given the heavy metal solution for two weeks, low esterified pectin was the most effective agents studies compared with others. They contributed to reduce lead concentration in liver and kidney as well as increased metal content in feces of laboratory animals. The results recommended that low esterified pectin can be considered as perspective compounds purposed for prevention and treatment of chronic lead poisoning.

Keyword: *Heavy metals; Lead; Pectin; water hyacinth leaves; Equilibrium study; waste water.*

INTRODUCTION

The effluent of industrial waste waters often contain considerable amounts of toxic and polluting heavy metals. It is well known that heavy metals such as Hg, Pb, Cr, Ni, Cu, Cd, and Zn are usually associated with tendency to accumulate in living organisms and are highly toxic when adsorbed into body (Wan Ngah *et al.*, 2004). Releases of Pb(II) ions to the environment have been increasing continuously as a result of industrial activity and technological development, posing a significant threat to the environment and public health because of toxicity, incremental accumulation in the food chain and persistence in the ecosystem. The main sources of lead ions posing a risk to human are diet, lead- based paint, metal ions in soil and dust around industrial areas and continuing use of leaded gasoline in some countries (Vaird *et al.*, 2004; Paoliello and De Capitani, 2005).

When entered the human body lead acts as a potential neurotoxin (Lindsay and Schneider, 2003) with no beneficial effects. In inner media lead ions binds proteins containing thiol groups as well as amide, phosphate and carboxyl groups. The largest amounts of the lead ions are stored in bones. Besides, lead can be found in brain, kidney, and liver. Therefore, chronic exposure to lead inevitably affects nervous, immune and hematopoietic

systems, as well as kidneys and gastrointestinal tract (Mazzolini *et al.*, 2001 and El-Safiy *et al.*, 2004). Nowadays the therapy of acute and chronic lead poisoning includes the following measures: elimination of all lead sources, administration of calcium and calcium containing products, nutritional and vitamin support and the use of specific metal chelators. Chelators are the agents possessing a unique capacity to irreversibly bind metal ions and eliminate them from the body through intestine and kidney (Kalia and Flora, 2005). Unfortunately up-to-date chelators cannot be used for a long treatment of the chronic lead poisoning due to their toxic effects on various organs and systems as well as on mineral balance (Smith *et al.*, 2000). Therefore, safe and effective agents with marked metal binding activity are required for treatment as well as for prevention of the chronic lead poisonings.

Pectins are the ionic plant polysaccharides, which main structural features are the linear chains containing more than 100 (1-4)-linked α -D-galacturonic acid residues Schols and Voragen, (1996), which metal binding capacity under in vivo and in vitro conditions was proved in the numerous studies Kartel *et al.*, (1999) and Khotimchenko *et al.*, (2006). At the same time, the studies on the capacity of different pectins to bind and remove lead ions were from wastewaters were not carried out yet. The main structural characteristic of all pectin substances is their degree of esterification indicating the number of galacturonic acid residues with methanol radical attached.

Omar and El-Shinnawy (2013), investigated the effect of contact time on Cr (VI) and Pb (II) adsorption on water hyacinth leaves powder and the rate of Cr (VI) and Pb (II) ions removal. It was found that the removal percentage of Cr (VI) and Pb (II) metal ions increased with increasing the contact time. The removal percentage were 70% for Cr (VI) and 82% for Pb (II) after 120 min. It is clear that at the beginning removal percentage increased rapidly in few minutes by increasing contact time, then removal % increased lightly and slowly till reach maximum value and this can be explained on the basis that as initially a large number of vacant surface sites are available for adsorption of metal ions but with passage of time the surface sites become exhausted (Zhan *et al.*, 2000). These results indicated that water hyacinth leaves powder has a very strong capacity for adsorption of Cr(VI) and Pb(II) ions in solutions.

Therefore, the aims of this study are investigate the sorption of lead ions by pectin compounds as well as the experimental conditions such as pH, agitation period, agitation rate and initial concentration using Langmuir and Freundlich models to fit the equilibrium

isotherm. In addition, the efficacy of the compounds was tested using the laboratory rats with modeled lead intoxication

MATERIALS AND METHODS

Chemical: Lead (Pb):

lead acetate trihydrate ($C_4H_6O_4Pb_3H_2O$) of molecular weight 379.33 was provided by Riedel Dehaen, Hannover, Germany. Each one gram of Pb is

found in 1.8307 g of finely powders of lead acetate. All other chemicals were of the highest quality available. Distilled water used throughout.

Pectin Preparation

High - esterified citrus pectin without additives was obtained from Herbsrtaith and Fox, Germany. The stated degree of esterification of this preparation was 60.0%. The pectin preparation contained no acetyl or amide groups. Initially pectin with a degree of esterification of approximately 1.2 % was prepared. During this process 100 g of high esterified citrus pectin was de-esterified in 1600 ml 50 % ethyl alcohol containing 20 g NaOH and 20 g KOH (30 min at 20 °C). After acidification, pectin was isolated from ethanol by filtration.

Preparation of low-esterified pectin was performed using a technique of alkali de-esterification according to *Ralet, et al, 2001*, with modifications. The sample of high - esterified pectin was used for preparation of samples of low-esterified pectin. Initially, pectin with the degree of esterification approximately 1.0% was prepared. During this process, 100 g of high-esterified citrus pectin was de-esterified in 1600 ml 50 % ethanol containing 20 g NaOH and 20 g KOH (30 min at 20°C). After acidification, pectin was isolated from ethanol by filtration.

Pectin extraction

Dried water hyacinth leaves powder was treated with 85 % ethanol at 70 °C for 20 min and filtered with miracloth. The residue (10 g) was stirred with oxalic acid/ammonium oxalate (0.25 %, pH 4.6, 400 ml) at 85 °C for 1 h. The compound was filtered with miracloth, and the filtrate was mixed with three volume of 96 % ethanol. After centrifugation at 14, 5000 x g for 10 min, the precipitation was washed with a series of 70 % ethanol and then oven - dried at 50 °C for 24 h (*Koubala et al., 2008*).

Galactouronic acid extraction.

The pectin content of high; low esterified and water hyacinth powder were determined as galactouronic acid by high performance liquid chromatography as described by *Hicks et al., (1985)* with modification, as follows:

200 mg of low ; high esterified pectin and pectin in water hyacinth powder, dispersed in 1 ml of iced-cold 80 % sulfuric acid, was allowed to set at 25°C for 18 hrs. The sample was then diluted to 13 ml, sealed in a vial, and placed in a boiling water bath for 5 hrs. The resulting dark solution was neutralized with soil calcium carbonate, filtered (0.2 um) and injected into the chromatography.

Determination of galactouronic acid

Galactouronic acid was identified by Hewlett Packard HP 1050 High performance liquid chromatography (HPLC) equipped with refractive index 1047 HP, degasser and autosampler. The chromatograph was fitted with Bio Rad HPX-87-C model (30 cm x 7.8 mm mid.) Isocratic elution system was used by deionized water at the flow rate 0.8 ml/min.

Experimental Procedures

Lead stock solutions with concentration 20.6 g/L were prepared using analytical-reagent grade PbNO₃. The stock solutions were then diluted to give

standard solutions of appropriate concentrations with controlled pH at 6.0 achieved by addition of either 0.1 M HCl or 0.1 M NaOH. Batch sorption experiments were conducted in 250 ml beakers and equilibrated using a magnetic stirrer. Then 50 ml aliquots of these standard solutions were placed in 250 ml beakers and added with 50 ml of solution containing 0.5 g of dry pectin preparation. Removal of pectin compounds from Pb(II) solution was performed by centrifuging at 3000 rpm for 10 - 20 min and following filtration through glass filter with a pore size 100 - 120 pm. Concentration of Pb(II) ions in supernatant was analyzed using Contra 700 AAS methods. The effect of Pb (II) sorption was studied in pH range 2.0 - 10.0. The pH of the initial solution was adjusted to the required pH value using either 0.1M HCl or 0.1 M NaOH. Pectins were equilibrated at the particular pH for about 120 min at 400 rpm and at an initial Pb(II) concentration 0.1 g/L using a bath controlled at 30°C.

The effect of agitation period was also studied to determine the optimum condition for sorption of Pb(II) ions. For batch kinetic studied 10 ml of solution containing 0.05 g of dry compound were equilibrated at optimum condition as mentioned earlier. The sorption system was placed in 50 mL beaker and stirred by a magnetic stirrer. At present time intervals, the aqueous samples (5 cm³) were taken and the lead concentration was assessed.

Sorption equilibrium studies were conducted at optimum condition using a contact time of 120 min at pH 2.0 - 10.0. According to the preliminary results pH value 6.0 was considered as most acceptable because all polysaccharides at this point possess highest binding activity and pH control requires minimum amount of HCl and NaOH. Bath controlled temperature was 24°C. Isotherm studies were conducted with a constant pectin preparation amount (0.05 g) and varying initial concentration of lead ions in the range of 0.05 - 0.6 g/L. Each experiment was at least duplicated under identical conditions. The metal accumulation (q) was determined as follows:

$$q = \frac{(C_0 - C_e) * V}{W}$$

where, C₀ is the initial lead concentration mg/L, C_e is the final or equilibrium arsenic concentration mg/L, V is the volume of the arsenic solution (ml) and W is the weight of the dry samples of high-esterified pectin and low esterified pectin (g). The amount of the metal ions bound by the compounds was expressed in milligram per gram of the dry sorbent.

Animals and diet

Male Sprague-Dawley albino rats weighting 150±10 g each were obtained from animal house of Food Technology Research Institute, Agriculture Research Center, Giza. All rats were allowed to acclimatize to laboratory environment and fed on basal diet for two weeks (adaptation period) prior to the study. The basal diet consists of protein (casein) 10%, cellulose 5 %, salt mixture 4 %, vitamin mixture 1 %, corn oil 10 %, and corn starch 70 % according to Lana Peter and Pearson (1971).

Experimental design

This part of study consisted of two experiments estimating influence of high; low esterified pectin and water hyacinth leaves on the removal of lead from inner organs (Liver and Kidney).

In the first experiment after the adaptation period, 80 rats were randomly divided into eight groups. All animals except the control group were daily given 2 ml of lead acetate solution containing 50 mg of lead per kg through gastric gavage for two weeks. The control group received 2 ml of distilled water through gastric gavage. Then half of the control rats and animals of the test group were killed by decapitation under slight anesthesia; inner organs was removed, weighed, rinsed and stored until analysis. For the next two weeks the remaining rats of control and lead groups were given only standard diet whereas rats of other groups were daily administered suspensions containing 0.5 g/kg high and low esterified pectin or water hyacinth leaves one hour before feeding through gastric gavage. At the end of experiment rats were killed and inner organs were removed, weighed, rinsed and prepared for lead analysis.

In the second experiment rats were randomized into seven groups. All animals except the control group were daily given lead acetate as described before for two weeks. The control group received daily 2 ml of distilled water. Then administration of lead was discontinued and all rats were put into individual cages. For the next 21 days all groups were fed standard diet and at the same time rats of the test groups were additionally given one hour before feeding through gastric gavage water suspensions containing 0.5 g per kg of high; low esterified pectin and water hyacinth leaves. Feces were collected daily, dried, ground and prepared for the lead analysis.

Metal concentration analysis

Lead residues in solution filtered in a course of the in *vitro* studied on lead binding capacity of high ; low esterified pectin ; water hyacinth leaves; liver and kidney were determined by Contra Atomic Absorption Spectrometry 700, according to the method of *Parker et al., (1967)*.

Statistical Analysis

The obtained data were statistically analyzed using F. Test - ANOVA test according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Pectin substrate

Chemical analysis of the pectin samples showed the following results. The content of pure galacturonan in the high-esterified pectin sample used in the experiments was 78.6 %, and the degree of esterification was approximately 60.5%. The intrinsic viscosity of high-esterified pectin used was 352 mL/g of galacturonan. Molecular weight was around 225 kDa.

The galacturonan concentration of the low-esterified pectin was 77.1%. The assay showed degree of esterification to be approximately 1.2%. The intrinsic viscosity of this pectin sample was 201 mL/g of galacturonan. Calculated molecular weight of low-esterified pectin was approximately 20 kDa. The free and esterified carboxyl group in the both pectin macromolecules were distributed in a random pattern. Both pectins are water soluble at pH values higher than 2.0.

The content of pure galacturonan in water hyacinth powder used in the experiments was 72.33 %, and the degree of esterification was approximately 40.93%. The intrinsic viscosity of water hyacinth pectin used was 252 mL/g of galacturonan. Molecular weight was around 125 kDa.

Effect of agitation period

Figure (1) shows the effects of agitation period on the metal uptake of pectins. Period required for equilibrium concentration between pectins and Pb (II) ions to be achieved can be found on the base of different Pb(II) uptake values obtained after various periods of incubation of the batch sorption system. Amount of Pb(II) bound by low-and high-esterified pectins increases within the beginning of agitation period and attains equilibrium at about 60 min, Pb(II) uptake by pectin in water hyacinth increases slower and attains equilibrium in 120 min. The main differences in the sorption rates among these compounds were observed within the first minutes of the agitation period. So, during the first minute of the period soluble pectins bounds 75% of their highest uptake under given conditions whereas insoluble pectin in water hyacinth bound only 30%. In 10 min, the differences of the Pb(II) uptake between soluble and insoluble pectin substances became insignificant. Longer period required for pectin in water hyacinth to bind Pb (II) ions is dependent on the rate of metal diffusion into pectin in water hyacinth beads.

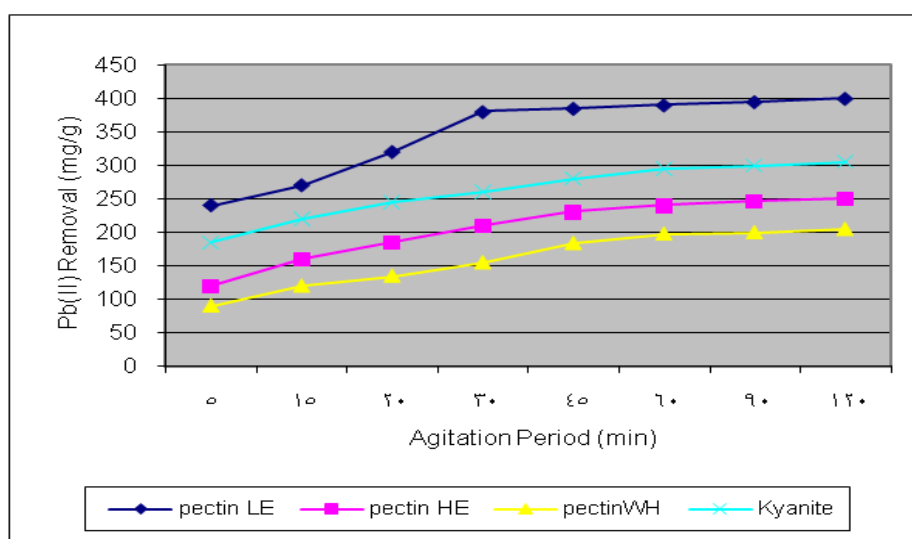


Fig.(1): Effect of the agitation period on the Pb(II) removal by different compounds pectins and kyanite

Effect of pH

In this study, knowledge of pH is important because the pH of solution strongly affects the sorption capacity of the pectin compounds regarding lead ions. Figure (2) shows

the effects of pH on the lead binding by low- and high-esterified pectin ; pectin in water hyacinth and kyanite. The maximum lead uptake by the high-esterified pectin was found at pH 8, whereas it is for pectin in water hyacinth was found at pH 7. Maximum sorption activity of low-esterified pectin was registered at the pH range from 4 -8 with a slight decrease toward the pH rise. At pH values higher than 8 there were registered dramatic decrease of the uptake capacities of all compounds studied, because these obviously results in polysaccharides becoming unstable *Lofgren et al. (2002)* and Pb(II) forming an insoluble hydroxide. Below pH 8.0, sorption gradually increases with the rise of pH of the solution. This could be explained by the phenomenon that the lower is pH the more protons are available in a free form to protonate carboxyl groups, reducing the number of binding sites in the pectin molecule.

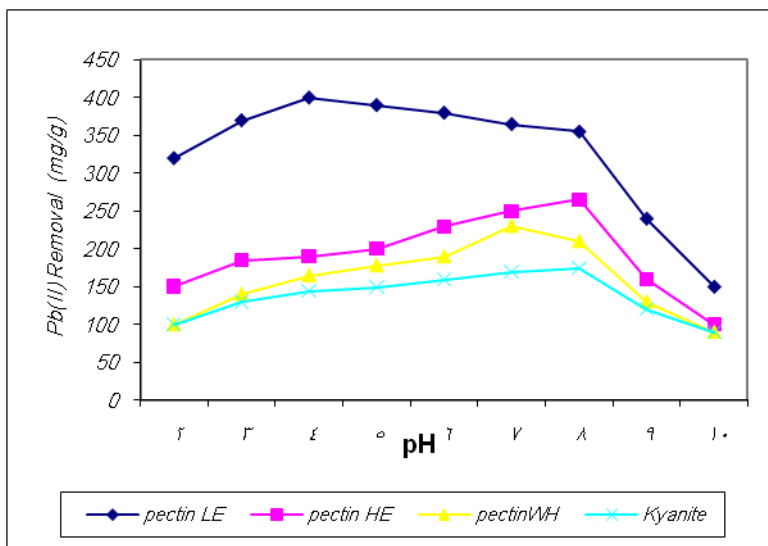


Fig (2) : Effect of pH on the Lead (ii) Removal by different compounds of pectin and kyanite

Effect of agitation rate

The influence of agitation rate on the binding of lead by pectin compounds was studied using following stirring speeds: 200, 300, 400 and 500 rpm. It was found that agitation rate has no influence on the values of lead uptake by low- and high-esterified pectins and pectin in water hyacinth leaves.

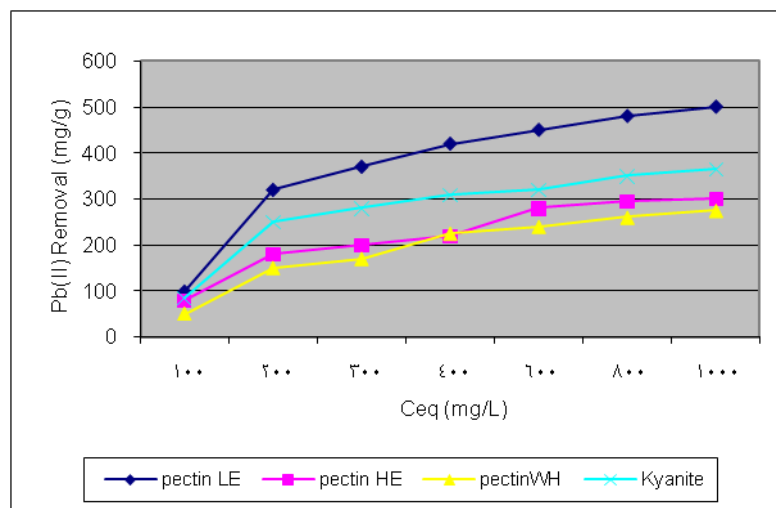


Fig (3): Equilibrium sorption of Pb(II) from aqueous solution using different compounds pectin and kyanite

Adsorption studies

Removal of lead by low- and high-esterified pectin; pectin in water hyacinth leaves and kyanite as a function of initial metal concentrations were studied at pH 6. Since the data for the curve are obtained at the same temperature, the curve is an isotherm. Therefore, there is a defined distribution of the metal ions in the sorption system, which can be expressed by one or more isotherm (Findon et al., 1993). Figure (3) shows the sorption curve displaying the amount of lead ions bound by the all samples used in the study. It can be seen that metal uptake increases while final metal concentration becomes higher. The isotherms are characterized by the initial region, which is represented as being concave to the concentration axis. The isotherm reaches a plateau, which can typically be described by the one or more mathematical models. The results obtained in our study were analyzed using Langmuir and Freundlich adsorption isotherms. The Langmuir equation is often used to describe equilibrium sorption isotherm, which is valid for monolayer sorption with a finite number of identical sites and is given by:

$$q = \frac{(q_{max} * bc_e)}{(1 + c_e)} \quad (2)$$

Where, q_{max} is the maximum sorption at monolayer (mg/g), C_e a final equilibrium concentration of lead ions, q the amount of lead ions bound per unit weight of the low- and high esterified pectin and pectin in water hyacinth at final equilibrium concentration (mg/g) and b is the Langmuir constant

related to the affinity of binding sites (mL /g) and is considered as a measure of the energy of sorption.

The following linearized plot of the Langmuir equation was used in this study which gives q_{max} and b :

$$C_e/q_e = (C_e/q_{max}) + 1 / (q_{max} b) \dots \dots \dots (3)$$

The widely used empirical Freundlich equation based on sorption on a heterogeneous surface is given by: $\log q_e = \log K_f + 1/n \log C_e \dots \dots \dots (4)$

Where, K_f and n are Freundlich constants indicating sorption capacity (mg/g) and intensity, respectively. K_f and n can be determined from linear plot of $\log q_e$ against $\log C_e$.

Calculated results of the Langmuir and Freundlich isotherms are given in Table (I). The results show that sorption of lead by low and high esterified pectin, pectin in WH and kyanite were better correlated ($R^2 > 0.99$) with the Langmuir equation. It can be explained by presence of finite number of homogenous binding sites in the pectin molecules, which is the basic condition of the Langmuir sorption model. Lead ions bound onto the homogenous carbon surface also form monolayer.

Table (I): Langmuir and Freundlich isotherm constant and correlation coefficients of Pb(II) binding capacity of different pectin compounds and kyanite

Sample	Langmuir			Freundlich		
	b, mLmg ⁻¹	q _{max} (mg g) ⁻¹	R ²	K _f (mg g) ⁻¹	n	R ²
Pectin HE	10.22	363.74	0.9969	355.69	2.97	0.8879
Pectin LW	20.35	635.94	0.9993	705.34	6.02	0.8701
Pectin WH	8.15	198.25	0.9938	211.25	0.987	0.8741
Kyanite	1.687	1.742	0.9945	1.894	1.452	0.8547

Data in table (I) shows the Freundlich plots of the lead sorption by pectin and kyanite. According to the values of R^2 . This model fits for description of interaction between the lead ions and kyanite.

The mechanism of interaction between lead ions and pectins are to be elucidated by binding of the metal ions with carboxyl groups located sites. The results show that intensity of binding processes and sorption capacity does not depend on solubility of the compound but closely relates to the number of the carboxyl groups in its structure (Plazinski, 2011). This implies formation of the junction zones between carboxyl groups of pectins and the lead ions according to the "egg-box" model. Kyanite bind lead via physical adsorption of the ions on its surface as it was initially described in the Langmuir model. The results suggest that under *in vivo* condition pectin in WH and low esterified pectin will be the most effective agent for removal of the lead ions in rats.

Animal Studies

In this study two weeks administration of lead results in significant increase of the metal concentration in inner organ. In liver the lead contents were 8.4 times higher than in the control while it reached 114.8 times higher in kidney. Within the next two weeks the lead concentration did not significantly change in inner organs (Table 2). The results show that administration of low- and

high esterified pectin and pectin in WH led to accelerated removal of the lead ions from inner organs. Both low esterified and high esterified pectins as well as pectin in WH contributed to metal elimination from kidney. Administration of the pectin with low degree of esterification results in 58.9% reduced lead concentration in kidney whereas administration of the high esterified pectin led to 55.8 % lowered lead storage. After the use of pectin in WH, the lead contents in kidney were reduced by 77.5 %. Kyanite did not affect lead concentration in kidney. It should be mentioned that after administration of low esterified pectin and pectin in HW there were significant increases of lead contents in liver in comparison with animals of control group and even with animals given lead acetate and not treated with low- and high esterified pectin. These findings can be explained by fast removal of lead from kidney and consequent accumulation of the metal in well perfused organ such as liver. This phenomenon is sometimes called a bound effect (Gerhardsson *et al.*, 1999).

Table (2): Lead content in inner organs and femur in rats given pectin compounds and kyanite in dose 1g /kg daily for 14 days after advance administration of lead acetate

Group	Lead Concentration (µg/g of dry weight)		
	Liver	Kidney	Femur
	14 days		
Control	6.3	1213.24	222.8
Lead acetate	33.5	19.9	122.3
	28 days		
Control	14.2	28.5	18.2
Lead acetate	25.6	1045.5	206.4
Lead acetate +pectin HE	14.3	579.2	295.3
Lead acetate +pectin LE	28.9	532.4	115.3
Lead acetate + Pectin WH	15.4	654.2	326.1
Lead acetate + Kyanite	20.2	725.8	330.2

HE= High esterified pectin; LE= Low esterified pectin; WH= Water hyacinth leaves

In all groups of animals given the lead acetate per os significantly increased metal concentration in feces were registered indicating continuous lead elimination through the digestive tract. Then removal of lead ions gradually reduced within the next three weeks. The use of low esterified as well as high esterified pectins contributed to more effective elimination of the lead ions from the body with feces. Pectin in WH also contributed to enhanced lead elimination but it was less effective than low- and high esterified pectins. Administration of kyanite did not change lead concentration in feces within the whole period of experiment (Table 3).

Table (3) : Effect of pectin compounds and kyanite on the lead excretion with feces with 4 weeks in rats preliminary exposed to lead acetate

Group	Fecal lead concentration ($\mu\text{g/g}$ of dry weight)			
	Day 0	Day 14	Day21	Day 28
Control	2.4 \pm 1.2	2.6 \pm 1.0	3.1 \pm 1.9	2.5 \pm 1.3
Lead acetate	2.8 \pm 0.9	6245.1 \pm 143.2	79. \pm 8.2	68.9 \pm 6.2
Lead acetate +pectin HE	3.0 \pm 1.1	6035.1 \pm 137.2	82.2 \pm 6.9	79.5 \pm 5.6
Lead acetate +pectin LE	2.1 \pm 0.9	5436.8 \pm 149.2	94.4 \pm 7.3	98.2 \pm 6.2
Lead acetate + Pectin WH	2.9 \pm 0.8	4853.4 \pm 146.2	55.4 \pm 8.2	51.3 \pm 7.2
Lead acetate + Kyanite	2.2 \pm 0.7	5056.9 \pm 135.2	58.8 \pm 9.2	52.6 \pm 7.3

HE= High esterified pectin; LE= Low esterified pectin; WH= Water hyacinth leaves

DISCUSSION

Lead is a potential toxin possessing no physiological value. Entered in low doses it affects functions of organs manifesting in lowered intelligence and behavioral problem (*Lindsay and Schneider, 2003*). It is well known that non-starch polysaccharides are essential food constituents possessing various beneficial effects on human systems with no pronounced adverse effects (*Krauss et al., 2001*). Therefore, their usage for elimination of the heavy metal ions from the body may considered as very prospective because they can be used for the long periods with low risk of adverse reactions.

In this study, we have demonstrated that low esterified pectin high metal binding capacity due to their physicochemical properties. According to the "egg box" model of interaction between pectins and bivalent metal (*Plazinski, 2011*), the quantity of the metal bound to the polysaccharide is determined by the number of active carboxyl groups. In accordance to this model in our experiments pectin with the degree of esterification about 1.2 % exerted higher comparison to high esterified pectin and pectin in WH. High pectin and pectin in WH are characterized by a major part of carboxyl group to be occupied with methyl radicals preventing interaction with the metal ions. Kyanite has another mechanism of interaction with metals generally caused by physical adsorption. This mechanism is less effective than "egg-box" complex-formation. Thus, these substances did not effectively remove heavy metal ions from inner organs.

In study experiments estimating pharmacologic efficiency of different pectins, it is of great importance to have the most complete characteristics of structural and physicochemical properties of the samples before the experimental study. Analysis of papers devoted to exploration of the correlation between structure of pectins and their pharmacological activities showed that most significant parameters are molecular weight, intrinsic viscosity, and degree of esterification and galactouronic acid content. In our study, we tried to make an analysis regarding some mentioned parameters of the structure of samples used in experiments. We may conclude that lead-

removing effects, in such degree as it was registered, must be typical of only the substances with structure and physicochemical properties as it was defined before experiments. The results obtained through the present study suggest that pectins with low degree of esterification may be considered as perspective source for creation of novel pharmaceuticals and food agents preventing and healing lead-induced injuries in human.

CONCLUSION

In conclusion, many chelating agents are currently used to manage lead toxicity. Physical properties of the pectin substances such as molecular weight, galactouronic acid content, degree of esterification, intrinsic viscosity, kyanite were determined before the experiments. Equilibrium studies of the preparations and lead (II) solution were performed at 30°C. The following results were obtained:-

- 1- The most effective pH for the removal of Pb(II) was a range from 7 to 8. Low-esterified pectin effectively bound Pb(II) with pH range 4-8.
- 2- The study showed that pectin substances bind heavy metals, in particular Pb(II). The metal uptake is dependent on the chemical structure of pectin and increases according to the reduction of the degree of esterification. Thus, the highest sorption activity was registered in low-esterified pectin. Adsorption studies showed that the Langmuir model of sorption processes is well fitted implying the homogenous character of the binding sites and their finite number. Although, low- and high-esterified pectins process water soluble properties sorption of the Pb(II) ions on their structure was the same as it was with pectin in WH beads. It can be concluded that pectin compounds are effective substances for the collection of metal ions in greater concentrations and the next steps of the studies should be performed to estimate lead-binding capacity of these compounds in low concentrations.
- 3- Sorption process is rapid with the first 20 min. of contact with all pectins samples studies. Maximum metal uptake was achieved in the first 30 min. It seems that sorption of Pb(II) is not influenced by such external factors as agitation rate.
- 4- At the same time, the most common, however, are non-specific and have some adverse effect in human such as induction of misbalance of essential microelements (Kalia and Flora, 2005). Because low-and high esterified pectins and pectin in water hyacinth leaves WH.

REFERENCES

- El-Safty, I.A.M., A.M.H. Afifi, A.E. Shouman and A.K.R. El-Sady (2004). Effects of smoking mid lead exposure on proximal tubular integrity among Egyptian industrial workers. *Arch. Med. Res.*, 35: 59-65.
- Findon, A.; G. McKay and H.S. Blair (1993). Transport studies for the sorption of copper ions by chitosan. *J. Environ. Sci. Health A Environ. Sci. Eng. Toxicol.* 28: 173-185.
- Gerhardsson L., J. Borjesson. S. Matlsson, A. Schutz and S.Skerfving (1999). Chelated lead in relation to lead in bone and ALAD genotype. *Environ. Res.*, 80: 389-398.

- Gomez, K. A. and A.A.Gomez (1984). Statistical procedures for agricultural research, John Wiley and Sons, Inc., USA.
- Hichs, K.B., C. P. Lim and M.J. Haas (1985). Analysis of uronic and aldonic acids, their lactones and related compounds by high performance liquid chromatography on cation-exchange resins. *J. Chromatography*, 319: 159 – 171.
- Kalia, K. and S.J.S. Flora (2005). Strategies for safe and effective therapeutic measures for chronic arsenic and lead poisoning. *J. Occup. Health*, 47:1-21.
- Kartel, M.T.; L.A. Kupchik and B. K. Veisov (1999). Evaluation of pectin binding of heavy metal ions in aqueous solutions, *Chemosphere* . 38: 2591 – 2596.
- Khotimchenko. M ; I. Serguschenko and Y. Khotimchenko (2006). Lead adsorption and excretion in rats given insoluble salts of pectin and alginate, *Int. J. Toxicol* : 25 :195 – 203.
- Koubala, B.B., L. I. Mbome; G. Kansci; F. Tchouanguep Mbiapo; M. S. Crepeau; J. F. Thibault and M. C. Ralet (2008). Physicochemical properties of pectins from ambarella a peels (*Spondias Cytherea*) obtained using different extraction conditions. *Food Chemistry* . 106 : 1202 - 1207.
- Krauss, R.M., R.H. Eckel, B. Howard, L. J. Appel and S.R. Daniels (2001). Revision 2000: A statement for healthcare professionals from the nutrition committee of the American heart association. *J. Nutr.*131: 132 – 146.
- Lana Peter, W. and A.E.G. Pearson (1971). Dietary requirements in laboratory animals and practice, acad. Press, London and New York. P. 142.
- Lindsay, T.I. and J.S. Schneider (2003). Lead neurotoxicity in children: Basic mechanisms and clinical correlates. *Brain*, 126: 5-19.
- Lofgren, C, P. Walkenstrom and A.M. Hermansson (2002). Microstructure and rheological behavior of pure and mixed pectin gels. *Eiromacromolecules*, 3: 1144-1153.
- Mazzolini, M., S. Traverso and C. Marchetti (2001). Multiple pathways of Pb^{+2} permeation in rat cerebella granule neurons. *J. Neuroch.*, 79: 407-416.
- Omar, T.M.Y. and A.M. El-Shinnawy (2013). Adsorption studies on the removal of hexavalent chromium and lead from contaminated wastewater using leaves of water hyacinth as an adsorbent. *J. Soil Sci. and Agric. Eng., mansoura Univ.*, Vol. 4 : 975 – 987.
- Paoliello, M.M. and E.M. De Capitani (2005). Environmental contamination and human exposure to lead in Brazil. *Rev. Environ. Corntam. Toxicol.*, :184: 59-96.
- Parker, M.M. , F.L. Humoller and D.J. Mahler (1967). Determination of copper , zinc and other elements in biological material. *Clin. Chem.*, 13: 40.
- Plazinski, W (2011). Molecular basis of calcium binding by polyguluronate chains. Revising the egg-box model. *J.Comput Chem.*, 32: 2988-2995.

- Ralet, M.C., V. Dronnet, H. C. Buchholt, and J. F. Thibault, (2001). Enzymatically and chemically de-esterified lime pectins: characterization, polyelectrolyte behaviour and calcium binding properties, Carbohydr. 336: 117 – 125.
- Schols. H.A and A. G. J Voragen (1996). Complex pectins: structure elucidation using enzymes, in: J.Visser, A.G.J. Voragen (Eds.) , Pectins and Pectinases, Elsevier Science, Amsterdam, pp. 3-19.
- Smith, D.R., N Calacsan, D. Woolard, M. Luck, J. Cremin and N.K. Laughlin (2000). Succimer and the urinary excretion of essential elements in a primate model of childhood lead exposure. Toxicol. Sci., 54: 473-480.
- Vaird, B., F. Pihan ,S. Promeprat and J. C. Pihan (2004). Integrated assessment of heavy metal (Pb, Zn, Cd) highway pollution: Bioaccumulation in soil, Graminaceae and land snails. Chemosphere, 55: 1349 – 1359.
- Wan Ngah, W.S., A. Kamari, Y.J. Koay (2004), Equilibrium and kinetics studies of adsorption of copper (II) on chitosan and chitosan/PVA beads, Int. J. Biol. Macromol. 34:151-155.
- Zhan, Y.B., A.Shukla; S.Shukla and K.L.Dorris (2000). The removal of heavy metal from aqueous solutions by sawdust adsorption-removal of Copper .J. Hazard. Mater, 80: 33 – 42.

دراسات إدمصاصية على الرصاص ثنائي التكافؤ باستخدام البكتين منخفض وعالي الإستر والبكتين المستخلص من أوراق ورد النيل.
عادل سالم عبد الرحمن نصر الدين احمد هاشم و عادل احمد بكر
المركز الإقليمي للإغذية والاعلاف- مركز البحوث الزراعية – الجيزة ، مصر

تم دراسة إدمصاص أيونات الرصاص من المحاليل المائية باستخدام مركبات البكتين المختلفة . ثم دراسة فاعلية البكتين منخفض الإستر ، البكتين عالي الإستر - والبكتين المستخرج من أوراق ورد النيل داخل المعمل وعلى فئران التجارب وتبين من نتائج هذه الدراسة ان أكثر فاعليه لمركبات البكتين المختلفة عند الرقم الهيدروجيني ما بين ٤ - ٥ . تم أيضا استخدام نماذج لانجمير وفريوديلش لدراسة الثوابت الحرارية و الإدمصاصية حيث أن التداخلات بين الانواع المختلفة للبكتين يمكن تفسيرها باستخدام نموذج لانجمير . ووجد أن أكبر كمية من أيونات الرصاص ترتبط مع البكتين منخفض الإستر. وفي دراسات بيولوجية للتنبؤ بإزالة كمية الرصاص من الكبد والكلى لفئران التجارب التي تجرعت بكميات من عنصر الرصاص لمدة اسبوعين وجد ان البكتين المنخفض الإستر كان أكثر فاعلية دون الانواع البكتينية الأخرى . وبالتالي أدى إلى إنخفاض تركيزات الرصاص بالكبد والكلى بالإضافة إلى زيادة كمية في براز حيوانات التجارب. من خلال هذه النتائج يتبين أنه يمكن التوصية باستخدام البكتين منخفض الإستر للوقاية والعلاج من التسمم المزمن بالرصاص.